

# PROJECT facts

U.S. DEPARTMENT OF ENERGY  
OFFICE OF FOSSIL ENERGY  
NATIONAL ENERGY TECHNOLOGY LABORATORY

Gasification  
Technologies

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## DEVELOPMENT OF AN INTEGRATED MULTI-CONTAMINANT REMOVAL PROCESS APPLIED TO WARM SYNGAS CLEANUP

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### Description

Advanced gasification systems will be needed to provide synthesis gas for advanced combined cycle power plants for hydrogen production and for chemical conversion plants. All of these advanced applications will require that sulfur-containing species, as well as other contaminants in the syngas, be reduced to parts-per-million (ppm) or in some cases parts-per-billion (ppb) levels.

Acid-gas removal technologies that are either currently available or under development include: (1) low-temperature or refrigerated solvent-based scrubbing systems using amines, such as MDEA, or physical solvents (i.e., Rectisol, Selexol, Sulfinol), or (2) high temperature sorbents. Typically, these gas-cleaning processes operate at temperatures that are either below or above the temperature of the downstream processing operations (e.g., for gas turbine fuel systems and catalytic synthesis processes), which are in the range of 300 to 700 °F. These temperature differences lead to lower energy efficiencies. The low-temperature clean-up processes require temperature reductions to below 100 °F and then reheating to downstream process temperature requirements; the high-temperature sorbent systems operate at 1000 °F, leading to unnecessary gas stream corrosivity.

The development of desulfurization systems that can be matched to the elevated temperature and pressure conditions of gasification processes (i.e., temperatures in the range of 300-700 °F and pressures in the range 400-1,200 psig) and that can be integrated with the warm-gas cleanup of other contaminants is, therefore, of critical importance for early commercialization of advanced gasification technologies being promoted by U.S. DOE in the FutureGen and Clean Coal Power Initiative programs.

GTI will develop an integrated, multicontaminant removal process in which hydrogen sulfide, ammonia, hydrogen chloride and heavy metals (including Hg, As, Se, Cd) present in coal-derived syngas will be removed to specified levels in a single process step. The solvent-based high pressure University of California Sulfur Recovery Process (UCSRP-HP) that directly converts hydrogen sulfide to elemental sulfur at 285 °F to 300 °F will be evaluated for removal of other contaminants in the same reactor column. The preliminary process concept has been verified using a batch reactor at the Gas Technology Institute (GTI) and the results have been found to be promising. The proposed process is tightly integrated and is expected to be significantly more economic both in terms of capital and operating costs.



## PARTNERS

Gas Technology Institute  
University of California, Berkeley

## PROJECT COST

**Total Project Value**  
\$449,957

**DOE/Non-DOE Share**  
\$359,957 / \$90,000

## CUSTOMER SERVICE

**I-800-553-7681**

## WEBSITE

[www.netl.doe.gov](http://www.netl.doe.gov)

Data critical to developing and evaluating UCSRP-HP technology for multi-contaminant removal from coal derived syngas will be obtained. During Phase-I, which is expected to last 18 months, extensive laboratory experiments will be conducted to investigate the effect of important process parameters on contaminant removal efficiencies, solvent stability and to study the reaction kinetics, reactor hydrodynamics and metal-corrosion related issues. The experiments will be conducted using simulated syngas in a specially designed high-pressure, high-temperature reactor setup that will be capable of producing up to 20 lb/day elemental sulfur. Laboratory data will be used to develop a computer simulation model that will later be used for techno-economic evaluation of the process and designing a pilot-scale demonstration unit for Phase-II work.

## Primary Project Goal

The primary goal of this project is to develop experimental data to demonstrate the technical feasibility of the UCSRP-HP process for multicontaminant removal from warm syngas. The specific tasks of the projects include (1) design, construction and operation of a UCSRP-HP bench-scale unit, (2) investigation of long-term (i.e., 1,000 hrs) solvent stability, (3) investigation of metal corrosion related issues for selecting suitable material of construction for the UCSRP reactor, (4) development of an Aspen-Plus based computer simulation model, and (5) techno-economic evaluation of the process applied to syngas cleanup for a 500 MWe coal-based IGCC power plant.

## Accomplishments

Preliminary studies at GTI indicate that this process is conceptually sound and can be further developed through proposed work into a promising low-cost technology for warm syngas cleanup.

The conceptual design for a high-pressure bench-scale test unit (design temperature of 450 °F, design pressure of 1000 psig) was completed. Through a competitive bid process, a vendor has been selected to complete detailed design and to fabricate the test unit with a delivery date in Spring 2006.



High Pressure Laboratory Reactor at GTI.

## Benefits

The proposed process is ideal for syngas desulfurization at 285 to 300 °F and at any given pressure (higher the better) and offers a tighter integration with the process for removal of trace contaminants and heavy metals. It is expected to be significantly lower in capital and operating cost compared to conventionally applied amine or physical solvent based acid-gas removal process followed by Claus/SCOT process. A techno-economic evaluation of the related low pressure process has found significant advantages (40% reduction in each of capital and operating cost) for the proposed scheme compared with conventional treating approaches., i.e., Claus plus SCOT tail gas treating. Additionally, testing done at GTI has shown negligible chemical consumption (including catalyst), unlike typical chemical costs of \$300 - \$1000 per ton sulfur removed found in competing processes.